

- Appl. No. 09/972,200
- In re Kunieda et al.
- Reply to Office Action of Sept. 10, 2004

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A system for fingerprint authentication, ~~which comprises~~
comprising:

~~which stores, regenerates, or matches a curve recognition system for storing,~~
~~regenerating or matching a shape of curves a fingerprint ridge~~[[,]] by using a specified group
of data [[in]] including one of a length, and/or angle and/or and position to express a shape of
~~curve the ridge, wherein~~

[[in]] ~~the system the curve recognition system uses a minutia and using a sequence of~~
several measure points on the ~~curve fingerprint ridge~~ [[,]] ~~which are determined so as to make~~
~~the same distances between those selected so that chords connecting the adjacent measure~~
points are of equal length, the shape of the fingerprint ridge is characterized by data of lengths
of chords ~~ares being~~ between a starting measure point and an ending measure point ~~points~~
~~among for every 3 consecutive measure points on the curve ridge.~~

Claim 2 (currently amended): The system as defined in claim 1, wherein the curve
recognition system is provided for recognition of the curve ridge expressed on ~~the periodic~~ a
discrete grid grids such as in the form of an array of pixels in a digital image, which

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determines position of the measure points by interpolating positions of two nearest adjacent grid pixels on the curve ridge, whose distances wherein from the starting measure point divides a length of a chord between the two nearest adjacent pixels at the ratio of lengths from a standard pixel on the curve to each of the nearest adjacent pixels are less and greater than the specified value, respectively.

Claim 3 (currently amended): ~~[[A]]~~ The system as defined in claim 1 for fingerprint authentication, further comprising in a sequence of processing:

means for block partitioning to partition whole image data into plural pieces of blocks~~[[.]]~~;

means for the first binarization to make gray scale image a binary black and white image by enhancing contrast of original image~~[[.]]~~;

means for deriving directions of the ridge in binary image~~[[.]]~~;

means for noise elimination to eliminate black data not located along directions of ridge~~[[.]]~~;

means for the second binarization to make gray scale image a binary data by enhancing contrast of original images~~[[.]]~~;

means for thinning by reducing width of ridge until ridge width becomes one pixel in size~~[[.]]~~;

means for false minutia elimination to eliminate plural ~~minutia~~ minutiae located closely to each other, an ending minutia located near bifurcation minutia, a minutia located closely to image boundary, and an isolated minutia without ridge, and

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means for extracting minutia to adopt remaining minutia as true minutia after above false minutia elimination.

Claim 4 (currently amended): [[A]] The system as defined in claim 1, wherein [[it]] the system utilizes, as [[a]] an additional feature of fingerprints, both said the minutia ridge shape and said the ridge shape of a secondary minutia, whose position is determined in associated association with each minutia.

Claim 5 (currently amended): [[A]] The system as defined in claim 3, further including ~~wherein~~ two kinds of extraction means for an ending minutia ~~are performed over~~ using the original black and white image and ~~its reversed~~ an inverted version of the original black and white image, instead of extracting both ending and bifurcation minutia ~~over using~~ just the original black and white image.

Claim 6 (currently amended): [[A]] The system as defined in claim 1, ~~wherein it~~ ~~includes~~ further including a cost effective calculation for judging true or false minutia, comprising:

means for taking [[2]] two-dimension coordinates with respect to an origin located at [[of]] a bifurcation point[[.]];

means for taking 3 points on different ridges leaving from the bifurcation point with the same distances from the bifurcation point[[.]];

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means for calculating ~~all~~ inner products of ~~2-point vector selected~~ all pairs of point-vectors that can be obtained from ~~said the 3 point-vector that correspond, respectively, to the 3 points, wherein inner product means sum of multiplication of horizontal components of said the 2 points with each other and multiplication of vertical components of said 2 points with each other~~[[.]]; and

means for judging the bifurcation as a false bifurcation minutia if all ~~3-said~~ calculated inner products are less than a specified value[[.]] , ~~and, Otherwise~~ otherwise, judging the bifurcation as a true bifurcation minutia [[.]]; and

means for judging ridge ending as a false ending minutia by using the ~~similar~~ inner products over valleys if all ~~3-said~~ inner products are less than a specified value , ~~and, [[.]]~~ Otherwise otherwise, judging the ending minutia as a true ending minutia.

Claim 7 (currently amended): [[A]] The system for fingerprint authentication as defined in claim 1, wherein ~~under assumption of consecutive frame inputs of identical fingerprints, [[a]] different part parts of the fingerprint image [[is]] are processed in said a way to generate numerical data for each frame input of the fingerprint image and processing of a whole fingerprint image is completed for plural frame inputs of the fingerprint image.~~

Claim 8 (currently amended): A system for fingerprint authentication, ~~wherein it uses comprising means of judge for judgment~~ on fingerprint verification without compensation for displacement of input fingerprint image, comprising;

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means for employing ~~memory area in~~ [[2]] two-dimensional array of memory areas
~~coordinates for judge judgment~~ [[.]];

means for calculating a similarity measure for each pair of minutia data between input
fingerprint image and registered template fingerprint [[.]];

means for accumulating the similarity measure, wherein the similarity measure is
stored in the memory area[[,]] whose corresponding to that of a ~~coordinates are the same as~~
~~vectors~~ vector between the positions of the said ~~2~~ two minutiae ~~minutia~~. The similarity
~~measure means any numerical data to express similarity between 2 minutia~~ [[.]];

means for judging input fingerprint as the same registered one if ~~the~~ a maximum value
in the memory area exceeds a specified value.

Claim 9 (canceled)

Claim 10 (currently amended): [[A]] The ~~curve recognition~~ system as defined in claim
7, ~~wherein under assumption of consecutive several frame inputs of identical fingerprint, it~~
takes 6th frame in a raster scan system of 25 frames per second ~~seconds~~ to complete processing
from image capture to numerical processing, which corresponds to input time of 6 or 7
frames.

Claim 11 (currently amended): [[A]] The system as defined in claim 1 ~~for fingerprint~~
~~authentication~~, comprising:

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means for extracting ~~said~~ numerical data of ~~said~~ the fingerprint ridge shapes of the ridge leaving from ~~said~~ the minutia[.]; and

means for matching the numerical data with template samples registered in advance [[or]] in a fingerprint database in said way.

Claim 12 (currently amended): [[A]] The system as defined in claim 1, wherein ~~on~~ ~~100-MOPS~~ a computer[[, it]] performs a sequence of processing ~~as said~~ including thinning, ~~said improvement or said~~ compensation, ~~said~~ binarization, ~~said~~ thinning, ~~said~~ collection and ~~said~~ matching of fingerprint feature data expressed by 40 or 60 bytes data in size. ~~MOPS~~ means unit of operation speed of computer, which represents million operations in one second.

Claim 13 (currently amended): [[A]] The system as defined in claim 1, further comprising:

means for extracting ~~said~~ fingerprint feature data of 40 or 60 bytes from ~~said~~ a fingerprint template transferred from an outer device or terminal equipment[.]; and

means for transferring result of matching with ~~said~~ the templates through communication network to the outer device or terminal equipment.

Claim 14 (currently amended): [[A]] The system as defined in claim 1, wherein [[it]] the system is used with one of a terminal or stand-alone equipment[[,]] ~~which posses a~~ ~~function such as search~~ for personal history, a key lock, an issue of various tickets, an access

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control and toll of gates, electric commerce, and a fund management in medical, social welfare, service, public service, and financial organization.

Claim 15 (currently amended): [[A]] The system as defined in claim 1, wherein [[it]] the system is embedded in hardware or software as a part of design data protection [[.]], [[To]] the use the hardware or software requires personal authentication with fingerprints.

Claim 16 (currently amended): [[A]] The system as defined in claim 1, wherein ~~criteria~~ a criterion of acceptance is ~~decided~~ determined by logic operations performed on or utilizing ~~among~~ extracted feature data of plural fingerprints.

Claim 17 (new): The system as defined in claim 10, further comprising:
means for rotating coordinates of all minutiae to a rotation angle around a specified origin point;
means for compensating a minutia ridge shape for rotation to the rotation angle; and
means for employing fingerprint matching without compensation for displacement of fingerprints.